ELECTROCHEMICAL CAPACITOR TECHNOLOGY FOR AUTOMOTIVE APPLICATIONS

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Maxwell Technologies, in conjunction with the U. S. Department of Energy (DOE), has been developing electrochemical capacitors since 1991. The development has centered on composite metal/carbon electrodes used in conjunction with non-aqueous based electrolytic solutions. The primary goal of this development effort has been to produce a device that is capable of load leveling the power requirements in electric and/or hybrid vehicles. The performance criteria for this device are the delivery of 5 Wh/kg of useful energy that can be use by the vehicle at an average power rating of 600 W/kg. The capacitor must also have an overall charge/discharge efficiency of 90% when tested on the PSFUDS cycle, and it must have a useful life of over 100,000 discharge cycles. The final device will operate at 350 V and will store 1.8 MJ of energy.

Earlier in the program, Maxwell delivered small capacitors, 15 farads, to the Idaho National Engineering Laboratories (INEL) for testing. These capacitors met the DOE performance goals when charged to their surge voltage of 3.0 volt. Recent efforts at Maxwell have focused on scaling this demonstrated performance to capacitors that are large enough to be used as modules in a full-scale device.

Maxwell Technologies is developing a 37 volt (48 volt surge) bipolar electrochemical capacitor. This device will store 11,000 J of energy when charged to full voltage. Large single cells to be used in the bipolar stack have been fabricated. These cells have a surface area of 194 cm^2, a capacitance of 155 farads, a resistance of 10 mohm, and a thickness of 0.13 cm. A three cell bipolar stack using these cells has been fabricated with performance that scaled in comparison to the single cells. The 16 cell stack will be fabricated and delivered to INEL in October, 1996. When operated at 48 volts the device should meet the DOE performance goals.

Large prismatic single cells have also been fabricated. These devices operate at 2.3 volt with a surge capability to 3.0 volt. Galvanostatic measurements of these devices showed a capacitance of 2,300 farads and a DC resistance of 650 µohm. These results translate to a packaged capacitance density of 5.0 F/cm^3 and a RC time constant of 1.4 seconds. In comparison, the small scale capacitors (15 farads) using similar electrode construction showed a packaged capacitance density of 4.6 F/cm^3 and a RC time constant of 1.1 seconds. These results demonstrate that the Maxwell's electrochemical technology scales easily to sizes required by the electric vehicle application with little or no loss in capacitor performance.

The next step in the development process will be to connect multiple modules in series and/or parallel to construct a full-scale device.

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